10:45

788-2 Thallium-201 Rest-Redistribution SPECT to Predict Improvement of Global Ventricular Function After Revascularization

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Thallium-201 rest-redistribution (Tl RR) imaging has been used to predict improvement of regional left ventricular (LV) function after revascularization. In the current study we have evaluated the use of Tl RR SPECT to predict improvement of global LV function after revascularization. Thirty-one patients with contractile dysfunction underwent Tl RR SPECT and resting echocardiography before either PTCA (n = 9) or CABG (n = 22). The echocardiographic and SPECT images were analyzed using a 13-segment model. Dysfunctional segments showing either normal perfusion, mildly reduced but fixed Tl uptake or significant redistribution were considered viable. LVEF was assessed before and 3 months after revascularization by echocardiography and radionuclide ventriculography. Improvement of LVEF ≥5% was considered significant. The patients were divided into 2 groups, according to the number of dysfunctional but viable segments on Tl RR SPECT (≤ 3 versus >3 segments). Four of the 17 (24%) patients with ≤ 3 dysfunctional but viable segments improved in LVEF. In contrast, all 8 (100%) patients with >3 dysfunctional, viable segments improved in LVEF. Moreover, a linear relation existed between the number of dysfunctional, viable segments and the improvement in LVEF ($y = 1.36*x - 1.7$, $r = 0.70$).

These data suggest that the patients with >3 dysfunctional but viable segments on Tl RR SPECT are likely to improve in global LV function after revascularization, and that the number of dysfunctional, viable segments is predictive for the improvement of LVEF.

11:00

788-3 Gated Technetium-99m SPECT Imaging Predicts Myocardial Viability in Revascularized Patients

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Myocardial perfusion imaging (MPI) is an accepted means to predict myocardial viability. Gated SPECT imaging with Tc-99m sestamibi (GPI) permits assessment of wall motion (WM) in addition to MPI. To evaluate the use of GPI in viability assessment, we prospectively evaluated 26 pts with rest gated Tc-99m SPECT sestamibi imaging pre-revascularization, 1 and 6 week post-revascularization (PTCA = 16, CABG = 14). Images were graded by 3 blinded readers using a 17-segment model. A total perfusion score of ≤ 10 and a WM score of ≤ 3 were considered viable. Individual total vascular defect and WM score were assessed for territories (LAD, CX, RCA) that were revascularized.

Results: Thirty vascular territories were analyzed. Viability was correctly predicted at either 1 or 6 weeks in 22 out of 30 territories by GPI. The prediction of perfusion score improvement post revascularization was significantly higher with GPI than with MPI alone. Sensitivity, specificity and positive predictive value (PPV) are as follows:

	MPI	GPI
Sensitivity:	54%	92%
Specificity:	15%	83%
PPV:	68%	81%

	Viability	
	present	absent
Viability by GPI+	22	5
Viability by GPI–	2	1

Conclusion: Gated Tc-99m sestamibi SPECT imaging predicts myocardial viability better than perfusion imaging alone.

11:15

788-4 Detection of Myocardial Viability by Dual-Isotope Tc-99m-Tetrofosmin and 18-FDG Single Photon Emission Tomography after Acipimox to Stimulate Glucose Uptake

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Aim: To study the ability of the Picker Prism 3000 3-head camera, fitted with ultra high energy (UHE) collimators, for assessment of myocardial I viability using dual-isotope simultaneous acquisition (DISA) SPECT with Tc-99m-Tetrofosmin and 18-FDG, after Acipimox. We compared with dobutamine stress echocardiography (DSE).

Methods: Forty-one pts with coronary artery disease, with mean ejection fraction 30% (range 11–39%) were studied with DISA-SPECT and DSE prior to revascularization. DSE was performed using dobutamine (5, 10, 20, 30, 40, and 40 μg/kg/min. with atropine). Standard views were obtained.

Sixty min. after 600 MBq Tc-99m-Tetrofosmin i.v. at rest, SPECT (low energy high resolution (LEHR) collimators, 360º, 3º steps of 30 sec.) was obtained. Acipimox (250 or 500 mg p.o.) in combination with a light carbohydrate-rich meal was given to stimulate myocardial 18-FDG uptake. Ninety min. later 185 MBq 18-FDG was injected; DISA-SPECT (UHE, 360º, 3º steps of 30 sec.) was started 45 min. post injection. For comparative analysis 16 segments were visually scored for DSE and DISA-SPECT, independently of each other. Segments with severe hypokinesis, akinesis, or dyskinesis at rest were scored for viability (improved wall motion during dobutamine infusion or ischemia with DSE; normal FDG/Tetrofosmin uptake or mismatch with DISA-SPECT, respectively) or scar. Segments without severe dyssynergies at rest were scored as "normal".

Results: The image quality of the Tetrofosmin perfusion images from DISA-SPECT was slightly inferior to the initial rest images with the LHER collimators, but the diagnostic value of both sets was the same. The myocardial 18-FDG uptake was good in most patients, yielding images of good quality. Of the 646 segments, 255 showed severe dyssynergy at rest. Of these 255, 28 were considered viable and 153 non-viable with both techniques; 33 segments with viability by DSE showed no viability with DISA-SPECT, and 41 non-viable segments by DSE showed viability with DISA-SPECT (agreement 71%).

Conclusion: Tc-99m-Tetrofosmin and 18-FDG DISA-SPECT with a 3-head camera after stimulated myocardial glucose uptake by Acipimox is a promising technique for assessment of myocardial viability. Further clinical follow-up in a larger group after revascularization is needed.

11:30

788-5 Dobutamine Tc-99m Sestamibi Gated SPECT: New Method for Myocardial Viability Assessment in Patients with Left Ventricular Dysfunction and Coronary Artery Disease

N. Zafrir, N. Avraham, J. Sulkes, S. Sclarovsky. *Rabin Medical Center, Beilinson Campus, Petah Tikva, Israel*

Perfusion imaging and dobutamine echocardiography are common but different modalities for myocardial viability assessment. This study investigates the use of dobutamine with sestamibi gated SPECT (GS) imaging, a new method which enables us to assess myocardial viability concomitantly by perfusion and contractile reserve. Twenty-one patients (pts) with triple coronary artery disease and severe left ventricular dysfunction were studied. All were intravenously injected with 30 mci of Tc-99m sestamibi for first-pass acquisition (mean EF 28 ± 5%). One hour later resting GS imaging was performed followed by infusion of dobutamine, starting dose 5 μg/kg/min, followed by 10 μg/kg/min for 5 min and throughout imaging. After processing, the myocardium was divided into 5 territories (T): septum, apex, anterior, inferior and lateral. Each was assessed for normal perfusion (>80% uptake), ab-normal (Ab)-viable (80–50% uptake) and Ab-nonviable (<50% uptake). Wall motion (WM) was assessed visually as normal, ab-viable if it improved with dobutamine and ab-nonviable if it did not. Interobserver variability was 8%. The agreement between WM and perfusion was 64%. Ninety-one T (87%) had Ab WM, of which 48 (53%) showed WM improvement with dobutamine and 57 (63%) were considered viable by perfusion (NS). Of the latter, 43/57 (75%) had WM improvement with dobutamine, in contrast to only 5 of 34 T (15%) considered nonviable by perfusion ($P < 0.001$). *Conclusion:* Dobutamine gated GS may be a useful method to assess myocardial viability both by perfusion and contractile reserve. However, its predictive value regarding functional improvement after revascularization needs to be explored.

11:45

788-6 Prediction of Improvement of Global Function After Revascularization in Patients with Ischemic Left Ventricular Dysfunction; Detection by F18-Fluorodeoxyglucose SPECT

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Many studies have focussed on the prediction of regional left ventricular (LV) function after revascularization. Although clinically more important, data on the prediction of improvement of global LV function are scarce. We evaluated the use of F18-fluorodeoxyglucose (FDG) and single photon emission computed tomography (SPECT) to predict improvement of global LV function after

revascularization. Twenty-two patients with contractile dysfunction (LVEF < 30%), underwent FDG SPECT (to assess glucose utilization), early thallium-201 SPECT (to assess perfusion) and resting echocardiography (to assess contractile status). All techniques were analyzed using a 13 segment model. Dysfunctional segments showing either normal perfusion or hypoperfusion with increased FDG uptake were considered viable. LVEF was assessed before and 3 months after revascularization by echo and radionuclide ventriculography. The patients were divided into 2 groups: group A consisted of 14 patients with 3 or more viable segments on FDG SPECT and group B consisted of 8 patients with 2 or less viable, dysfunctional segments. In group A the LVEF improved significantly from 25 ± 6% to 32 ± 6% (P < 0.01). Conversely, in group B the LVEF remained unchanged (24 ± 6% vs 25 ± 6%, NS). Considering an improvement of LVEF >5% significant, FDG SPECT correctly identified 12/12 (100%) of group A patients with viable myocardium, whereas 8/10 (80%) group B patients without viability were predicted. This study shows that FDG SPECT can identify patients who improve in global LV function after revascularization.

789 Exercise Functional Capacity and the Effect of Training in Patients With Coronary Artery Disease

Wednesday, March 19, 1997, 10:30 a.m.–Noon
Anaheim Convention Center, Room A19

10:30

789-1 Effect of Exercise Training in Post-MI Heart Failure: One Year Follow-up with Magnetic Resonance Imaging (MRI)

U. Goebbels, G. Dziekan, J. Myers, P. Dubach, W.H. Reinhart, R. Ratti, J. Bremerich [1], P. Buser [1], P. Müller. [1] *Kantonsspitäler Chur and Basel, Switzerland, Palo Alto DVAMC and Stanford University, Stanford, CA, USA*

Exercise training is now an accepted therapeutic intervention in patients with chronic heart failure (CHF). However, long-term follow-up of controlled exercise trials have not been performed. We followed 25 patients with CHF due to CAD that had been randomized to an intensive two month exercise training program or a control group (control group: n = 12, age 55 ± 7 years, EF 33.3 ± 6%; *exercise group:* n = 13, age 56 ± 5 years, EF 31.5 ± 7%). In the one year follow-up period, both groups were encouraged to perform regular exercise, but no formal program was imposed. Two patients in the control group experienced cardiac decompensation requiring hospitalization, and one patient in the exercise group died suddenly. At one year however, the remaining 24 patients were stable. Changes in oxygen uptake at maximal exercise (VO2 max, ml/kg/min), and at the lactate threshold (VO2 Lt, ml/kg/min), and left ventricular end-diastolic volume (LVEDV, ml) determined by MRI before and after the training period and at the one year follow-up were as follows:

	Exercise Group			Control Group		
	pre	post	1 year	pre	post	1 year
VO_2 max	19.7 ± 3	23.9 ± 4.8*	24.2 ± 4.6	18.8 ± 3.9	20.0 ± 4.3	19.4 ± 6.7
VO_2 Lt	13.6 ± 2.6	18.9 ± 2.2**	17.6 ± 3.8	13.7 ± 2.9	11.8 ± 2.0	14.8 ± 3.8
LVEDV	184.7 ± 47	192.4 ± 40	195.4 ± 38	179.8 ± 52	180.5 ± 51	190.5 ± 52

*$p < 0.05$ within group; **$p < 0.001$ within and between groups

Intensive exercise training in patients with CHF results in a significant improvement in VO2 max acutely, and this improvement is sustained over one year. Measures of ventricular volumes and function by MRI at one year demonstrated no adverse effects due to exercise training. Control patients showed no improvement in exercise capacity over the follow-up period, and also demonstrated no deterioration or improvement in MRI measures of volume or function.

10:45

789-2 Differential Effects on Peak Oxygen Consumption and Anaerobic Threshold during High- versus Low-Frequency Exercise Training in Patients with Coronary Artery Disease

W. Nieuwland, M.A. Berkhuysen, D.J. van Veldhuisen, P. Rispens, K.I. Lie. *University Hospital Groningen, Netherlands*

Although a wide variation of exercise training programs are applied during cardiac rehabilitation (CR), little is known about the relationship between exercise volume (time and intensity) and outcome. We therefore randomized patients with coronary artery disease either to a high-frequency (10 exercise sessions a week) or a low-frequency (2 exercise sessions a week) exercise training program during 6 weeks CR (duration of each session was 1 ½ hour).

130 Patients (114 men, 16 women; mean age 52.4 ± 9.3) were included after a recent coronary event (75% myocardial infarction, 9% coronary angioplasty; 10% unstable angina). In both programs the change in exercise capacity was highly significant ($p < 0.001$) (*full-time:* peak oxygen consumption [VO_2] = +14.0%, peak workload [W] = +17.0%, anaerobic threshold [AT] = +31.6%; *part-time: peak* VO_2 = +13.7%, *peak* W = +14.6%, AT = +10.0%). *Peak* W and AT increased significantly more during the full-time program (respectively, $p = 0.030$; $p < 0.001$), while there were no significant differences in increase of *peak* VO_2 between both programs.

High-frequency exercise training increases exercise capacity more than low-frequency exercise training. This holds especially for exercise capacity measured as *peak* W and AT, but less when measured as peak VO_2. It may be speculated that this would imply a physiological improvement during daily life; its clinical relevance is unknown and requires further study.

11:00

789-3 Spontaneous Changes in Exercise Capacity Following MI and CABG: Reduced vs. Preserved LV Function

G. Dziekan, U. Goebbels, J. Myers, P. Dubach, R. Ratti, W.H. Reinhart, P. Müller, M. Kuhn. *Kantonsspital Chur, Switzerland, Palo Alto DVAMC and Stanford University, Stanford, CA, USA*

The decrement in exercise capacity secondary to deconditioning and the left ventricular stunning associated with MI or CABG spontaneously improves post event. However, the impact of the status of the left ventricle on these improvements is unknown. Sixty seven patients one month after MI or CABG were randomized to a training (n = 34, age 59 ± 7) or a control group (n = 33, age 55 ± 6) and were followed over an additional one month period. Forty two patients had an EP > 55% (22 in the training group (Ex), 20 in the control group (Co)), and 25 patients had an EF < 40% (12 Ex, 13 Co). Below, cardiopulmonary exercise test results are stratified according to normal or reduced left ventricular (LV) function; maximal oxygen uptake (VO2 max) and oxygen uptake at the lactate threshold (VO2 Lt) are expressed in ml/kg/min:

		Pre		Post	
		Ex	Co	Ex	Co
VO_2 Lt	normal LV	15.4 ± 5	13.2 ± 3	17.2 ± 3	15.0 ± 3
	reduced LV	13.6 ± 3	13.7 ± 3	18.9 ± 2**	11.8 ± 2
VO_2 max	normal LV	22.6 ± 4	21.0 ± 4	26.4 ± 5**	25.0 ± 3**
	reduced LV	19.4 ± 3	18.8 ± 4	25.1 ± 5*	19.1 ± 4

*$p < 0.05$ pre vs. post within group, **$p < 0.05$ pre vs. post between normal LV and reduced LV

Control patients in the normal LV group showed progressive improvements in exercise capacity during the three month follow-up, whereas control patients in the reduced LV group remained unchanged. These data suggest that patients with severely depressed LV function strongly benefit from rehabilitation, whereas most patients with preserved LV function following MI or CABG improve spontaneously.

11:15

789-4 Effects of Training on The Recovery of Autonomic Nerve Activity During Exercise After Coronary Artery Bypass Surgery

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Parasympathetic nerve activity (PNA) is suppressed and sympathetic nerve activity (SNA) is augmented after coronary artery bypass graft (CABG). To determine the effects of aerobic exercise training on the recovery in PNA and SNA during exercise after CABG, 28 patients (age: 60.4 ± 7.8 years. No. of grafts: 2.6 ± 0.7) were randomly divided into the training (T) group who started two-week AT level exercise training by a cycle ergometer at one week after CABG and the control (C) group who did non-supervised walking exercise for 2 weeks. They performed cardiopulmonary exercise tests using a cycle ergometer at 1 week, 3 weeks, 3 months, 6 months and 1 year after surgery. The heart rate variability was measured during 20 w steady-state pedaling and high frequency of power spectrum (HF; 0.15–0.6 Hz) was employed as an index of PNA. Norepinephrine level (NE) and cardiac output (CO) by the dye dilution method were also measured. NE at 20 w decreased from 1 to 3 weeks after surgery in both groups (by 0.39 ng/ml in T, 0.40 ng/ml in C). Peak VO_2 increased in both groups (by 2.7 ml/min/kg in T, 1.0 in C), but delta values were larger in the T group than the C group throughout the